Hole's Human Anatomy and Physiology

Twelfth Edition

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Chapter 2 Chemical Basis of Life

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2.1: Introduction

Why study chemistry in an Anatomy and Physiology class?

- Body functions depend on cellular functions
- Cellular functions result from chemical changes
    - Biochemistry helps to explain physiological processes

2.2: Structure of Matter

Matter – anything that takes up space and has mass (weight). It is composed of elements.

Elements – composed of chemically identical atoms:

- Bulk elements – required by the body in large amounts
- Trace elements - required by the body in small amounts
- Ultra trace elements – required by the body in very minute amounts

Atoms – smallest particle of an element

Table 2.1 Some Particles of Matter

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TABLE 2.1 | Some Particles of Matter

Name	Characteristic	Name	Characteristic
Atom	Smallest particle of an element that has the properties of that element	Neutron (n^0)	Particle with about the same weight as a proton; uncharged and thus electrically neutral; found within an atomic nucleus
Electron (e^-)	Extremely small particle with almost no weight; carries a negative electrical charge and is in constant motion around an atomic nucleus	Ion	Particle that is electrically charged because it has gained or lost one or more electrons
Proton (p^+)	Relatively large atomic particle; carries a positive electrical charge and is found within an atomic nucleus	Molecule	Particle formed by the chemical union of two or more atoms

Elements and Atoms

- All matter is composed of elements
- Elements are the parts of compounds
- Elements are:
  - Bulk elements
  - Trace elements
  - Ultratrace elements
- The smallest parts of atoms are elements

Atomic Structure

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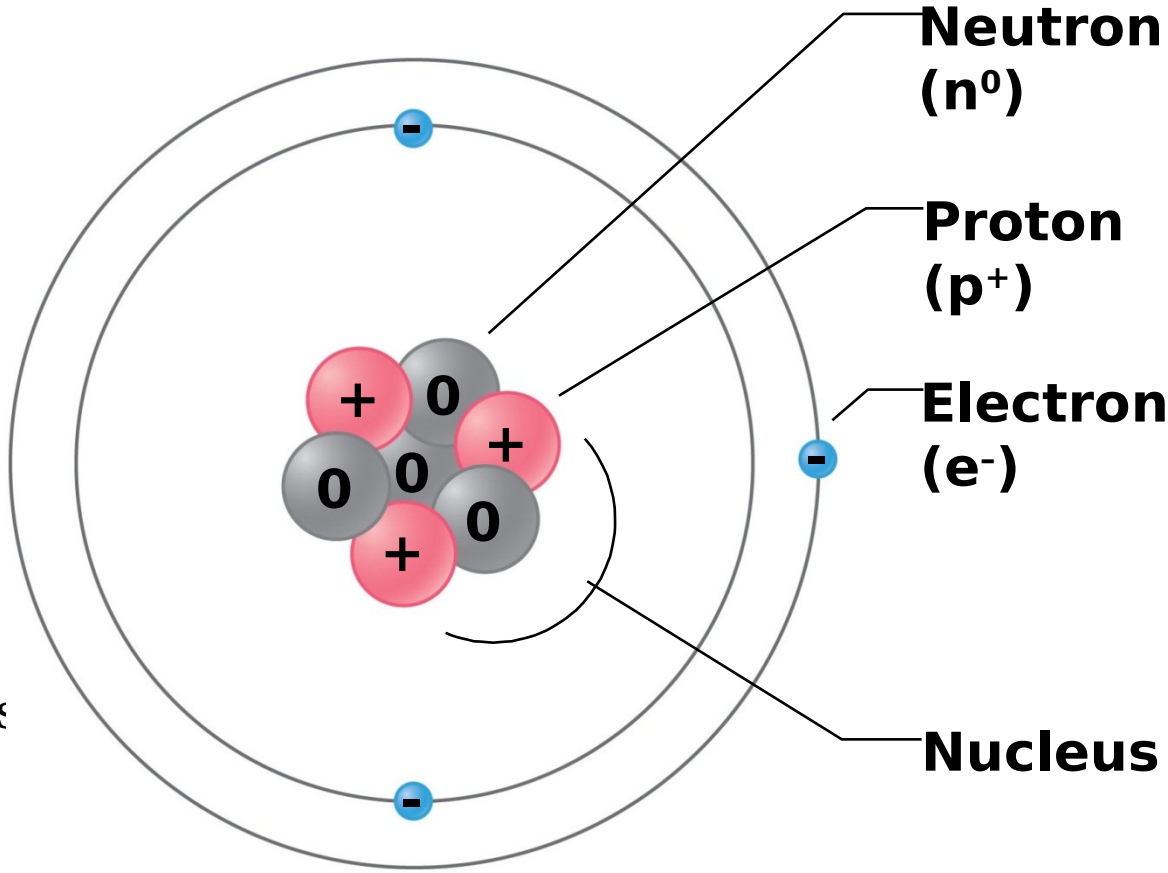
Atoms - composed of subatomic particles:

- Proton – carries a single positive charge
- Neutron – carries no electrical charge
- Electron – carries a single negative charge

Nucleus

- Central part of atom
- Composed of protons and neutrons
- Electrons move around the nucleus



Lithium (Li)

Atomic Number, Mass Number and Atomic Weight

Atomic Number

- Number of protons in the nucleus of one atom
- Each element has a unique atomic number
- Equals the number of electrons in the atom

Mass Number

- The number of protons plus the number of neutrons in one atom
- Electrons do not contribute to the weight of the atom

Atomic Weight

- Average of mass numbers of the **isotopes** of an element

Isotopes

Isotopes

- Atoms with the same atomic numbers but with different mass numbers
- Different number of neutrons
- Oxygen often forms isotopes (O^{16}, O^{17}, and O^{18})

Molecules and Compounds

Molecule – particle formed when two or more atoms chemically combine

Compound – particle formed when two or more atoms of different elements chemically combine

Molecular formulas – depict the elements present and the number of each atom present in the molecule

H_2 $C_6H_{12}O_6$ H_2O

Bonding of Atoms

- Bonds form when atoms combine with other atoms

- Electrons of an atom occupy regions of space called electron shells which circle the nucleus

- For atoms with atomic numbers of 18 or less, the following rules apply:
  - The first shell can hold up to 2 electrons
  - The second shell can hold up to 8 electrons
  - The third shell can hold up to 8 electrons

Bonding of Atoms

- Lower shells are filled first

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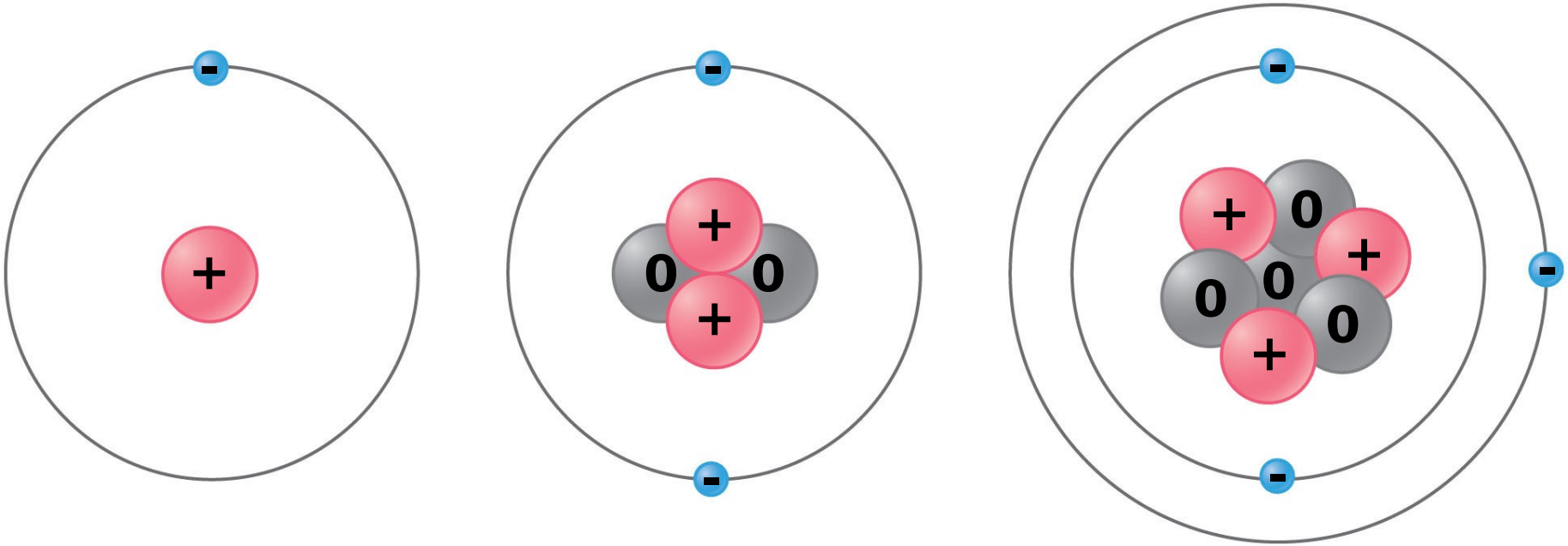


Hydrogen (H) **Helium (He)** **Lithium (Li)**

Bonding of Atoms: Ions

Ion

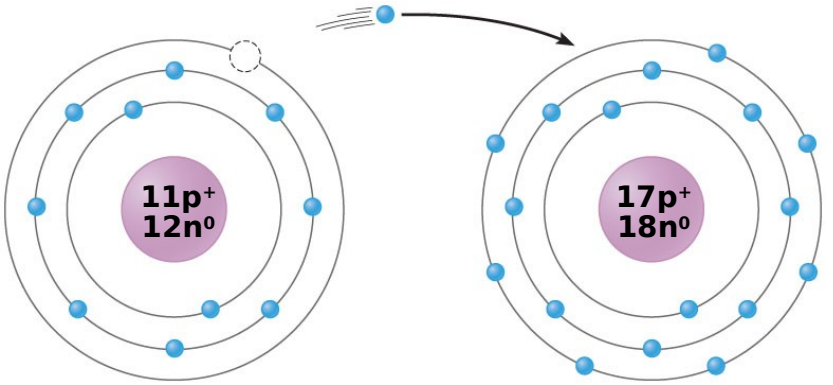
- An atom that gains or loses electrons to become stable
- An electrically charged atom

Cation

- A positively charged ion
- Formed when an atom loses electrons

Anion

- A negatively charged ion
- Formed when an atom gains electrons



Ionic Bonds

Ionic Bonds

- An attraction between a cation and an anion
  - Formed when electrons are transferred from one atom to another atom

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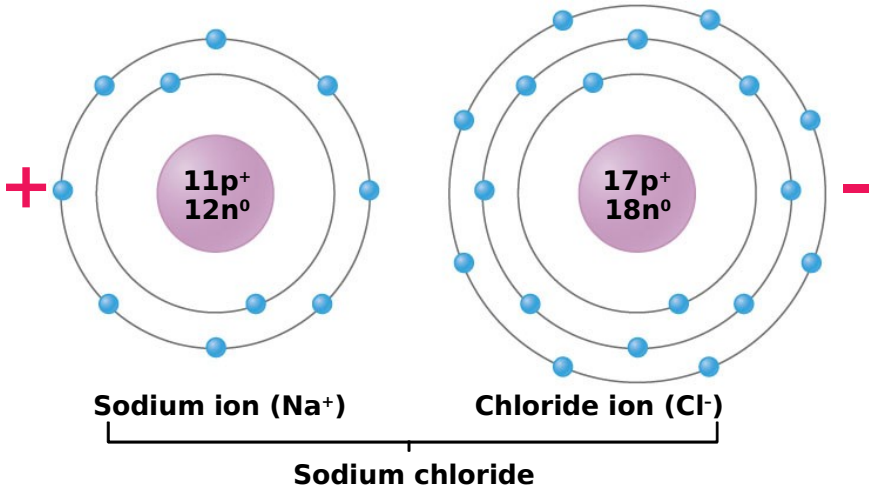

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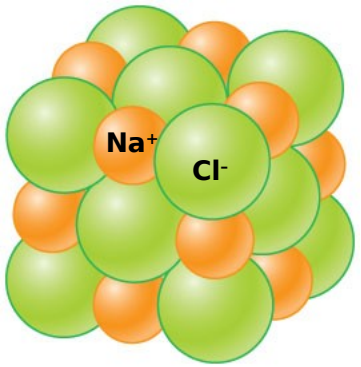

Covalent Bonds

- Formed when atoms share electrons

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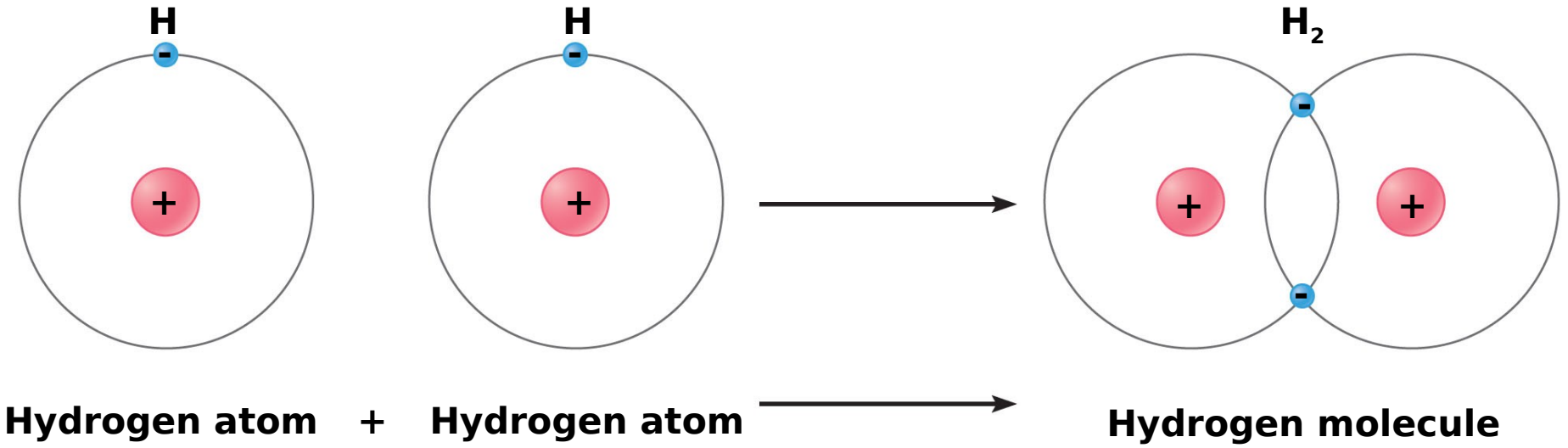

- Hydrogen atoms form single bonds
- Oxygen atoms form two bonds
- Nitrogen atoms form three bonds
- Carbon atoms form four bonds

H — H
O = O
N ≡ N
O = C = O

Bonding of Atoms: Structural Formula

- Structural formulas show how atoms bond and are arranged in various molecules

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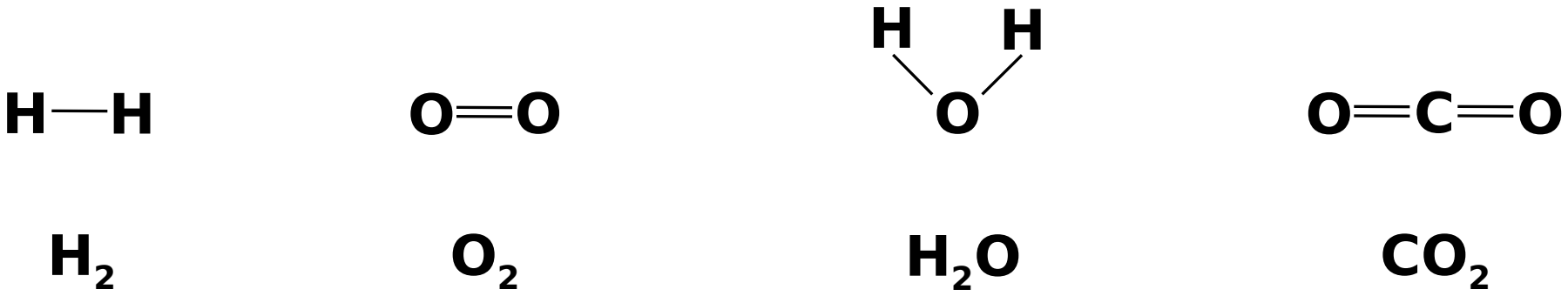
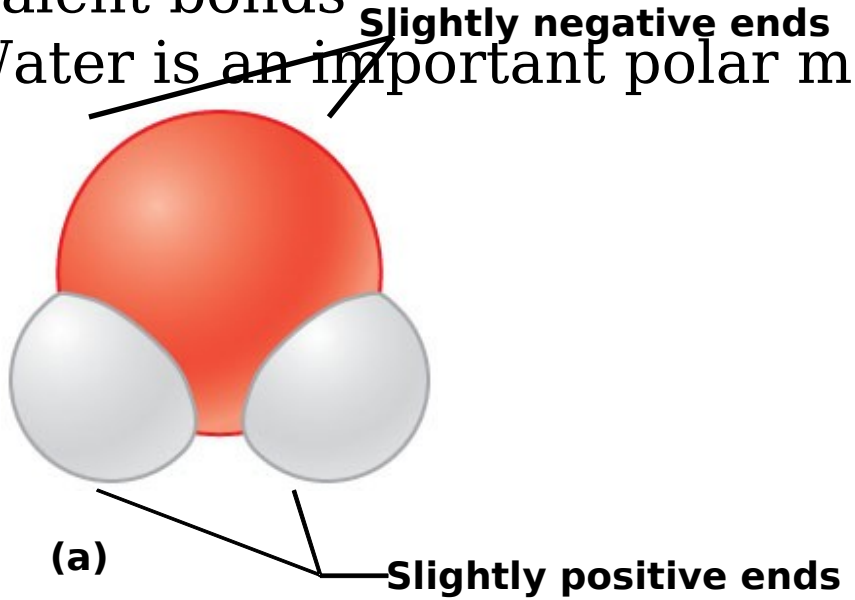


Bonding of Atoms: Polar Molecules

Polar Molecules

- Molecule with a slightly negative end and a slightly positive end
- Results when electrons are not shared equally in covalent bonds
- Water is an important polar molecule



Hydrogen Bonds

Hydrogen Bonds

- A weak attraction between the positive end of one polar molecule and the negative end of another polar molecule
- Formed between water molecules
- Important for protein and nucleic acid structure